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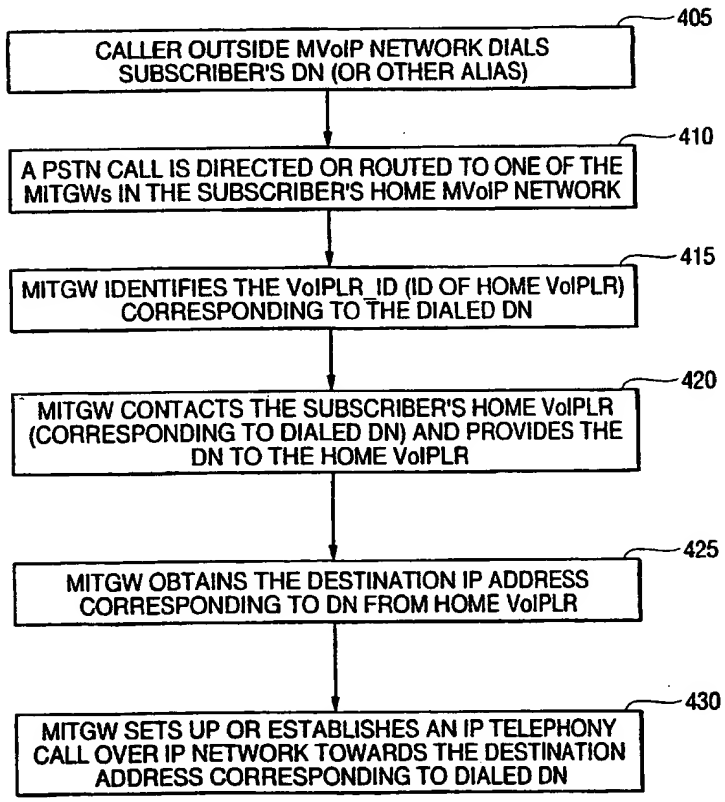

(57) Abstract: A system is provided for allowing users to roam between different IP telephony networks, or between subnetworks within an IP telephony network. A subscriber terminal connects to a local subnetwork that is different from its home subnetwork. The subscriber terminal registers with a serving location register corresponding to the local subnetwork. The serving location register stores updated location information, such as a current network address at which the subscriber terminal can be reached when connected to the local subnetwork. The subscriber terminal's home location register corresponding to the subscriber's home subnetwork receives and stores the updated network address for the subscriber terminal. A request for a call to the subscriber is received. The subscriber terminal's current network address is obtained from the subscriber's home location register and the IP telephony call is set up towards the subscriber terminal's current network address.

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MOBILITY IN PACKET-SWITCHED TELEPHONY NETWORKS

Technical Field

This application generally relates to packet-switched telephony networks, such as IP telephony networks, and more particularly to a technique to allow roaming or mobility between such packet-switched telephony networks.

Voice or telephony services can now be provided over a packet-switched network, such as the Internet. These packet-switched -telephony networks are commonly referred to as IP telephony networks because the Internet Protocol (IP) is the primary protocol used over the Internet. One IP telephony standard, for example, is the International Telecommunications Union (ITU) H.323 standard.

Fig. 1 illustrates an example of an IP telephony network, also known as a Voice over IP (VoIP) Network. The VoIP network includes a gatekeeper function, one or more gateways and a packet-switched network (e.g., a portion of the Internet).

The gatekeeper function is optional and provides call authorization for both accepting and placing calls in its zone or area of control. A gatekeeper can also allocate bandwidth, can maintain call detail records, and can perform other network management functions.

A packet-switched- telephony gateway bridges a circuit switched network such as the Public Switched Telephone Network (PSTN) and a packet-switched network such as an IP network or the Internet. The IP telephony gateway bridges the PSTN and IP networks to allow phone-to-phone and phone-to-personal computer (PC) multimedia communications (voice, video and/or data). The IP telephony gateway provides the

appropriate translation between transmission formats (for example, H.225.0 of an H.323 endpoint to/from H.221 of an H.320 endpoint) and between communication procedures (for example, H.245 of an H.323 endpoint to/from H.242 of an H.320 endpoint). The IP telephony gateway also performs call setup and clearing on both the network side and the switched circuit network side. Translation between video, audio, and data formats may also be performed in the gateway. In general, the purpose of the IP-telephony gateway is to complete the call in both directions between the network endpoint and the switched circuit network endpoint in a transparent fashion.

An example of IP telephony gateway is the H.323 gateway (implementing the ITU H.323 standard). H.323 gateways allow interoperation of H.323 systems with other audio/video conferencing systems on Integrated Services Digital Networks (ISDN), plain old telephone systems (POTS), Asynchronous Transfer Mode (ATM), and other transports.

An IP telephony gateway operates as an endpoint on the IP-telephony network that provides real-time, two-way communication between IP telephony terminals on the IP-based network and other ITU terminals on a switched-circuit network, or to another IP-telephony gateway. Switched Circuit Network connectivity is achieved in the IP telephony context by using gateways for H.320 (ISDN), H.324, H.323, POTS, and other endpoints on other networks.

Fig. 1 is a diagram illustrating an example IP telephony network. Referring to Fig. 1, when an incoming call (1) reaches an IP telephony gateway (GW) (here indicated as Originating IP telephony GW), the gateway contacts the gatekeeper it is registered with asking to set up a call towards the dialed number received from the incoming call set up request (Access Request, ARQ, 2). The gatekeeper translates the dialed number (or directory number) into the IP address of the Destination IP-telephony gateway, i.e. the gateway that has to be reached in order to reach the final destination of the call, and provides this IP address to the originating IP telephony gateway (Access Confirmation, ACF, 3). The Originating IP-telephony GW sets up an IP-telephony call over the packet-switched network or IP network towards the Destination IP-Telephony GW providing its IP address and the dialed number (Call setup, 3). The Destination

IP-telephony GW contacts the gatekeeper it is registered with (it may be the same as the Originating IP-telephony GW or a different gatekeeper) asking to accept a call incoming from the Originating IP-telephony GW (ARQ, 4) and directed towards the dialed number. If the gatekeeper grants the incoming call to the Destination IP-telephony GW (ACF, 5), the Destination IP-telephony GW establishes the PSTN call (call, 7), and then the call is established between the two IP-telephony GWs over the IP network (call establishment, 6). The destination IP-telephony gateway translates the IP packets into the appropriate format for transmission over the PSTN.

However, IP telephony standards and products are currently defined only for fixed networks. Mobility has not been considered in IP telephony in the sense that IP telephony subscribers are not allowed to roam between IP telephony networks.

For example, a subscriber in one area of the country is registered with a local gatekeeper. If the subscriber moves or travels to another part of the country, the subscriber will not be able to connect to the gatekeeper in the new part of the country because the new gatekeeper has no information describing the subscriber.

In addition, subscribers can roam in cellular communication systems. In Global System for Mobile (GSM) communications, a visiting location register (VLR) and a home location register (HLR) are used. The VLR contains relevant data of all mobile stations currently located in a serving Mobile Services Switching Center (MSC). The HLR is a database in charge of the management of the mobile subscribers. The data stored in the HLR includes service subscription information and location information (the identity of the currently serving VLR to enable routing of mobile-terminated calls). A Mobile subscriber ISDN number (MSISDN) is a number that can be dialed by a user to reach a GSM subscriber. The PSTN routes this call based on the MSISDN to the gateway function of the MSC (GMSC). The GMSC, based on its internal tables, correlates the MSISDN number to the specific HLR, which has to be queried to obtain subscriber information. The HLR replies by providing a roaming number for routing a call to the subscriber. The GMSC then re-routes the call to that particular number.

However, the use of HLRs and VLRs in cellular systems permits roaming only for cellular calls provided over the PSTN. IP-telephony networks do not allow subscribers to roam.

Therefore, a need exists for a technique that allows subscribers to roam between different IP telephony networks or subnetworks.

Disclosure of Invention

According to an embodiment of the present invention, a technique is provided to allow roaming or mobility between packet-switched telephony networks or subnetworks (such as between IP telephony networks). According to an embodiment of the present invention, one or more packet-switched telephony networks or VoIP networks having mobility or roaming capabilities is provided, each such network being referred to as a Mobile VoIP (MVoIP) network. A technique is described herein which supports roaming between MVoIP networks and for the routing of calls to mobile users or subscribers roaming from a MVoIP network to another MVoIP network, or roaming between subnetworks within a MVoIP network, with each subnetwork including one or more areas.

According to an embodiment of the present invention, a VoIP Location Register (VoIPLR) is connected to each subnetwork, and includes a database for storing subscriber profiles. Each subscriber terminal of a MVoIP network is statically associated with (homed by) one VoIPLR at subscription time, referred to as the subscriber's Home VoIPLR. Each VoIPLR is associated with a unique VoIPLR Identification (VoIPLR_ID). Each VoIPLR corresponds to a specific sub-network of the MVoIP network, according to one embodiment of the invention.

When a subscriber terminal roams to a new subnetwork or to a new MVoIP network, the subscriber terminal registers with the local VoIPLR serving the new subnetwork (the "serving VoIPLR") to provide the serving VoIPLR the subscriber's current IP address (the IP address where the subscriber can be reached) and status.

After the subscriber terminal registers its current (temporary) IP address and status to the serving VoIPLR, the serving VoIPLR then contacts and provides the subscriber's updated location (including the subscriber's temporary IP address) and status (e.g., connected or not) information to the subscriber's Home VoIPLR. In this manner, the subscriber's Home

VoIPLR always will contain the subscriber terminal's current location and status information, regardless of the subscriber's location.

When a caller outside the MVoIP network dials an alias (such as a directory number or DN) to place a call to a subscriber, a PSTN call is placed to a Mobile IP Telephony Gateway (MITGW) in the called subscriber's MVoIP network. Based on the dialed DN, the MITGW contacts the subscriber's Home VoIPLR to obtain the called subscriber's current status and location. The MITGW then sets up an IP telephony call over a packet-switched network (such as the Internet) towards the IP address corresponding to the dialed DN.

In a similar manner a call originating from within the MVoIP network can be delivered to a called subscriber. According to an embodiment, a calling subscriber registers with a control entity (such as a gatekeeper). The calling subscriber then contacts the gatekeeper and requests an IP telephony call to called subscriber identified by a DN (or other alias). Based on the DN, the gatekeeper contacts the called subscriber's home VoIPLR, obtains the subscriber terminals current status and location, and sets up an IP telephony call between the calling subscriber and the called subscriber over a packet-switched network (e.g., the Internet).

In this manner, the present invention allows subscribers to roam within different subnetworks of a MVoIP network or between different MVoIP networks.

Brief Description of the Drawings

Fig. 1 is a diagram illustrating an example of an IP telephony network.

Fig. 2 is a block diagram illustrating an example of Mobile Voice over IP (MVoIP) Networks according to an embodiment of the present invention.

Fig. 3 is a flow chart illustrating a registration procedure according to an embodiment of the present invention.

Fig. 4 is a flow chart illustrating call delivery to a subscriber from a PSTN according to an embodiment of the present invention.

Fig. 5 is a diagram illustrating call delivery to a subscriber from a PSTN according to an embodiment of the present invention.

Fig. 6 is a flow chart illustrating call delivery within the MVoIP network where the calling party is registered with a control entity according to an embodiment of the present invention.

Best Mode for Carrying out the Invention

Introduction

According to an embodiment of the present invention, a technique is disclosed to allow roaming between VoIP networks. As used herein, a VoIP network having mobility or roaming capabilities is referred to herein as a Mobile VoIP (MVoIP) network. A technique is described herein which supports roaming between MVoIP networks and for the routing of calls to mobile users or subscribers roaming from a MVoIP network to another MVoIP network, or roaming between subnetworks within a MVoIP Network

According to an embodiment of the present invention, each user belonging to MVoIP network is identified by an alias. The alias can take many forms, so long as it identifies the user. The alias can be a Directory Number - DN (e.g., E.164 format) that can be dialed to set-up a call towards the user. The user can also be identified or associated with a Logical Name - LN.

Also, it is assumed that each user of a MVoIP network is a subscriber of the MVoIP network. Thus, users will be referred to hereinafter as subscribers. Each subscriber is associated with a globally unique identifier - a SubscriberID.. The subscriber is associated with a profile, which may include information describing the subscriber including the subscriber's SubscriberID, the subscriber's directory number (DN) and, optionally, the Logical Name associated to the subscriber.

The SubscriberID is used by the subscriber to identify itself and by the VoIPLR to retrieve the corresponding subscriber profile. Because the subscriber belongs to a MVoIP network, the subscriber is also associated with an IP address. For example, the subscriber's IP address is seen as the transport address at which the subscriber can be reached on the packet-switched network (e.g., the subscriber's IP network address). The subscriber's IP address can be allocated both statically (i.e., the address is assigned by the MVoIP network at subscription time and, as such, stored in the subscriber profile) and/or dynamically (i.e., assigned when the subscriber connects to the MVoIP network and, optionally, changed at

every time the subscriber reconnects; the address is stored in the subscriber profile every time the user reconnects). According to an embodiment of the present invention, the subscriber terminal can have a different (and temporary) IP address each time it connects to a new MVoIP network or subnetwork. For example, the new current IP address can be generated or obtained using IP address configuration protocols, such as Dynamic Host Configuration Protocol (DHCP), or other techniques.

In order to support roaming or mobility in MVoIP networks, some additional functional elements or capabilities are provided according to an embodiment of the present invention. In an example embodiment of the present invention, the standard IP telephony network capabilities are augmented through the introduction of two functional elements: a VoIP Location Register (VoIPLR) and a Mobile IP Telephony GW (MITGW), described in detail below.

As used herein, the subscriber's Home MVoIP network refers to the MVoIP network with which the user has the subscription, whereas the Serving MVoIP network refers to the MVoIP network where the subscriber is currently located.

MVoIP Network Architecture

Referring to the figures in which like numerals indicate like elements, Fig. 2 is a block diagram illustrating an example of Mobile Voice over IP (MVoIP) Networks according to an embodiment of the present invention. MVoIP network 1 202 includes one or more subnetworks, including, subnetwork 1 (subnet 1) 210 and subnetwork 2 (subnet 2) 230. Although two subnetworks are shown, any number can be provided within a MVoIP network. Subnetwork 1 210 includes subnetwork area A 212 and subnetwork area B 214. Similarly, subnetwork 2 230 is divided into area A 232 and area B 234. A subscriber terminal Y 222 is connected to subnetwork 1 210 and a subscriber terminal Z 244 is connected to subnetwork 2 230. Similarly, there may be any number of areas in each subnetwork.

Referring to Fig. 2, one or more gatekeepers are connected to each subnetwork. Each gatekeeper operates as a control entity because it controls the establishment of IP telephony calls in a particular zone or area. Gatekeeper 1 (GK1) 216 is connected to area A 212 and gatekeeper 2 (GK2) 218 is connected to area B 214 of subnetwork 1 210. Also, Gatekeeper 3 (GK3) 236 is connected to area A 232 and gatekeeper 4 (GK4) and gatekeeper 5 (GK5) are

connected to area B 234 of subnetwork 2 230. Each subnetwork corresponds to a portion of a packet-switched network (e.g., a portion of the Internet, or a Local Area Network, a portion of a Wide Area Network, etc.).

According to an embodiment of the present invention, a VoIP Location Register (VoIPLR) is connected to each subnetwork. VoIPLR 1 220 is connected to subnetwork 1 210 and VoIPLR 2 242 is connected to subnetwork 2 230. As described in detail below, each VoIPLR is a database that stores a record or profile on subscribers and allows the subscribers to roam between MVoIP networks and subnetworks.

In addition, according to an embodiment of the present invention, the subnetworks are connected to the PSTN 250 via one or more Mobile IP telephony gateways (MITGWs). For example, as shown in Fig. 2, MITGW 1 260 is connected between PSTN 250 and subnetwork 1 210. Likewise, MITGW 2 262 and MITGW 3 264 is connected between the PSTN 250 and subnetwork 2 230. A terminal X 252 is connected to PSTN 250 and may or may not be a MVoIP network subscriber. The other terminals 222 and 244 are presumed, for this example, to be MVoIP network subscribers.

According to an embodiment of the present invention, each area may correspond to a gatekeeper zone described in H.323. As such, there may be one gatekeeper for controlling each zone or area. Alternatively, there may be many gatekeepers associated with each area (e.g., each area includes many zones), or there may be one gatekeeper for many areas.

According to an embodiment of the present invention, there may be many MVoIP networks connected to one another. The present invention allows subscriber terminals to roam between MVoIP networks and between subnetworks (within one MVoIP network). For example, as shown in Fig. 2, MVoIP network 2 270 is connected to MVoIP network 1 202. In a similar fashion to MVoIP network 1, MVoIP network 2 270 includes a subnetwork 3 272 (only one of the subnets is shown), a gatekeeper 6 (GK6), MITGW 4 278, a VoIPLR 3 276 and a subscriber terminal W 280 connected to subnetwork 3 272. MITGW4 278 is connected to the PSTN 250. The particular network configuration shown in Fig. 2 is provided only as an example embodiment that is used to explain the concepts of the present invention. The present invention is not limited to the configuration illustrated in Fig. 2.

The Mobile Voice over IP Telephony Network Location Register (VoIPLR)

Each subscriber of a MVoIP network is statically associated with (homed by) one VoIPLR at subscription time, referred to herein as the Home VoIPLR. Each VoIPLR is associated with a unique VoIPLR Identification (VoIPLR_ID). Each VoIPLR corresponds to a specific sub-network of the MVoIP network. (Alternatively, each VoIPLR could correspond to a specific MVoIP network).

As described above regarding Fig. 2, each MVoIP sub-network can be divided into different areas. When the subscriber terminal connects to a MVoIP network (or subnetwork), the MVoIP network identifies the particular MVoIP network, subnetwork or subnetwork area to which the subscriber terminal is connecting. According to an embodiment of the invention, each subscriber terminal receives the identity of the sub-network area (SNA_ID) to which the terminal is connecting. Because each subnetwork includes several subnetwork areas (SNAs), the SNA_IDs corresponding to a sub-network are each associated with the VoIPLR_ID of the VoIPLR in that sub-network. As noted above, there is one VoIPLR for each subnetwork.

In addition, there is a direct relation or correspondence between the SubscriberID and the VoIPLR_ID of the VoIPLR that homes the subscriber (the Home VoIPLR). The VoIPLR_ID identifies the Home VoIPLR of a subscriber. The Home VoIPLR_ID can be derived from a subscriber's SubscriberID. In this way, from the SubscriberID it is possible to identify the VoIPLR that is home to the subscriber (the subscriber's Home VoIPLR). The VoIPLR_ID of the Home VoIPLR can be derived (or obtained) from the SubscriberID in several different ways. For example, a look-up table can be used to identify a Home VoIPLR_ID corresponding to each SubscriberID (because there is only one Home VoIPLR per subscriber). Alternatively, the VoIPLR_ID itself can be embedded or provided within the SubscriberID (e.g., provided as a portion of the SubscriberID), such as a suffix or prefix in the SubscriberID.

The VoIPLR is a database that contains the location information needed to locate the subscriber and deliver the services. The location information is an address (e.g., network address or IP address of the subscriber) towards which calls have to be forwarded to reach the subscriber terminal.

Each VoIPLR can contains two types of records or profiles:

* Complete subscriber profile, if the VoIPLR is the Home VoIPLR for the subscriber. When the subscriber terminal is located in (or connected to) the sub-network corresponding to the subscriber's Home VoIPLR, the VoIPLR contains the complete service profile for the subscriber, including the subscriber's name, SubscriberID, aliases (e.g., DN and Logical Name), subscriber service and the subscriber's current status (e.g., connected or not connected) and location (i.e., IP address at which the subscriber can be reached and an identification of the MVoIP network, subnetwork or area where the subscriber is located).

* Roaming subscriber profile, for subscribers currently connected to the subnetwork corresponding to the VoIPLR. A Roaming subscriber profile is stored in the current VoIPLR (corresponding to the subnetwork where the subscriber is currently connected or located) if the current VoIPLR is different from the subscriber's Home VoIPLR. In other words, the subscriber is roaming if he/she is located in a subnetwork outside the subnetwork corresponding to his Home VoIPLR.

For users roaming to a different subnetwork, the Roaming subscriber profile could be all or a subset of the Complete subscriber profile which may downloaded into the serving VoIPLR from the subscriber's Home VoIPLR upon request from the serving VoIPLR.

With such a structure for the MVoIP network, subscribers moving to another sub-network of the same MVoIP network or moving between MVoIP networks are considered roaming. In this way subscribers roaming between MVoIP networks and inside a MVoIP network are managed in the same way.

If the subscriber is connected to an MVoIP network (serving or home), the location information contained in the current VoIPLR record is an IP address where a mobile terminated IP telephony call can be routed in the MVoIP network to reach the subscriber terminal. If the subscriber is not connected, the location information can be either void or could be a default IP address (e.g. answering machine).

Mobile IP-Telephony Gateway (MITGW)

The Mobile IP Telephony GW (MITGW) is an IP Telephony GW augmented with mobility support, as described herein. The MITGW translates the received directory number (DN) of a call to the VoIPLR_ID of the Home VoIPLR of the called subscriber. The MITGW can then communicate with the Home VoIPLR to obtain the current location and status of the

called subscriber (the subscriber corresponding to the DN). The MITGW then establishes the IP telephony call over the packet-switched network (e.g., Internet) between the MITGW and the current IP address of the called subscriber to complete the call. As an example, the data packets of the IP telephony call can be provided between directly between the MITGW and the IP address of the called subscriber, while the signaling can be routed through the gatekeeper.

A registration procedure described below is used to constantly maintain updated status and location information of the subscriber terminal at the subscriber's Home VoIPLR The subscriber's current location stored in the Home VoIPLR includes the IP address at which the subscriber can be reached and an identification of the MVoIP network, subnetwork or subnetwork area where the subscriber is located (e.g., the network or subnetwork or subnetwork area to which the subscriber terminal is connected). An example of such a network identification is the SNA_ID which can be stored in the Home VoIPLR to identify the current subnetwork area, a subnetwork_ID to identify the current subnetwork and/or a MVoIP_ID to identify the current MVoIP network where the subscriber is located.

The subscriber status can include, for example, whether the subscriber terminal is connected or not connected to the network. A subscriber can also select other status options, such as blocking all incoming calls, while allowing the subscriber to place outgoing IP telephony calls. If a call is received that is intended for a subscriber that is either not connected to the network or has blocked all incoming calls, the receiving MITGW (after obtaining the called subscriber's status and location from the called subscriber's Home VoIPLR), can either decline to place the requested call (e.g., return a busy or unavailable indication to the caller because the called party is not connected or incoming calls are blocked) or route the call to a predetermined IP address associated with the subscriber, such as the subscriber's answering machine or voice mail system.

Each MITGW is able to derive or determine the VoIPLR_ID of the subscriber's Home VoIPLR based on a received directory number (DN) or other alias. For example, the VoIPLR_ID can be identified based on the DN using a look-up table. Because the Home VoIPLR contains the current location and status of the called subscriber, the MITGW can obtain the current location (including the IP address where the subscriber can be located) of

the called subscriber based on the Home VoIPLR_ID. According to an embodiment of the present invention, the VoIPLR_ID may actually be or include the IP address of the Home VoIPLR. In this way, the MITGW is able to forward or establish the call over the IP network between the MITGW and the called subscriber regardless of the subscriber's current location.

Registration

When a subscriber connects to a MVoIP network, a registration procedure is performed in order to update the subscriber status and location information.

Fig. 3 is a flow chart illustrating a registration procedure according to an embodiment of the present invention.

At block 305, the subscriber obtains an identification of the subscriber's location within the MVoIP network (i.e., the SNA _ID identifying the subnetwork area where the subscriber terminal is located). A different SNA_ID may be broadcast in each subnetwork area. The subscriber terminal may or may not register depending on whether it detects it has moved to a new subnetwork area (by detecting a new SNA_ID). The subscriber terminal can compare its current SNA_ID to the previous SNA_ID to determine if the subscriber terminal is located in a new subnetwork area. Even if already registered in an area, the subscriber terminal may simply provide its new status to the gatekeeper in the area (e.g., indicating that the subscriber terminal is now available to receive calls). If already registered in the area, the subscriber terminal can de-register with the Serving VoIPLR just before the subscriber terminal disconnects from the network (so that the subscriber's Home VoIPLR will receive this updated status information). The remainder of the description of Fig. 3 assumes that the subscriber terminal will perform registration.

At step 310, the subscriber terminal connects to the MVoIP network and provides its SubscriberID. For example, the subscriber terminal may connect to the MVoIP network by connecting to a gatekeeper located in the subnetwork where the subscriber terminal is located, and provides its SubscriberID to the gatekeeper. The SubscriberID of the registering subscriber terminal is forwarded by the gatekeeper to the serving VoIPLR in the subnetwork. The serving VoIPLR is the VoIPLR which corresponds to or serves the local subnetwork to which the subscriber has connected (i.e., where the subscriber terminal is located). Each

subnetwork includes one or more subnetwork areas. There is one VoIPLR which serves each subnetwork.

At block 315, the subscriber terminal obtains or generates a new (current) IP address based on the SNA_ID, and then provides its IP address, SubscriberID, its current status (e.g., connected or not, able to receive incoming calls or not) and old SNA_ID to the serving VoIPLR. For example, this information can be provided to the serving VoIPLR through a gatekeeper. The subscriber may alternatively provide this information directly to the serving VoIPLR.

The subscriber may generate or obtain an IP address in a variety of different ways. For example, the subscriber's new address may be obtained using Dynamic Host Configuration Protocol (DHCP). If the subscriber's IP address is dynamically allocated, the subscriber can have a Home IP address (used by the subscriber when located in its Home MVoIP network). If the subscriber terminal roams to a new MVoIP network, subnetwork or a new area (outside its home), a temporary IP address corresponding to the visited area is used by the subscriber until the subscriber roams to a different area, where a new temporary IP address corresponding to the new visited area will be used by the subscriber terminal.

A Home IP address may be used each time the subscriber is connected to its Home MVoIPLR, and a temporary IP address can be generated and used for each new area, subnetwork or network the subscriber visits outside his Home. Other techniques can be used to generate or obtain new or updated IP addresses as the subscriber roams between or even within MVoIP networks.

Referring to Fig. 3 again, at block 320, the serving VoIPLR examines the SubscriberID provided by the subscriber terminal and identifies or derives the VoIPLR_ID (identifying the subscriber terminal's Home VoIPLR) which corresponds to the received SubscriberID. As noted above, there is one VoIPLR_ID (identifying the Home VoIPLR) corresponding to each SubscriberID. The Serving VoIPLR, for example, can use a look-up table to identify the Home VoIPLR_ID, or the VoIPLR_ID may be provided directly within the SubscriberID itself.

At step 325, the serving VoIPLR compares the VoIPLR_ID (identifying the subscriber's Home VoIPLR) to its own VoIPLR_ID. Two cases are possible.

If the serving VoIPLR is the subscriber's Home VoIPLR, the registration procedure performs blocks 330 and 335.

At block 330, the Home VoIPLR updates the subscriber's current location (e.g., IP address where calls directed to the subscriber can be routed and the serving SNA_ID) and status (e.g., connected or not connected) in the subscriber's Complete profile stored at the subscriber's Home VoIPLR. The subscriber's Home IP address can be used in this case. The IP address where calls directed to the subscriber can be routed can be either the actual IP address of the subscriber terminal or an IP address of a serving gatekeeper.

At block 335, the Home VoIPLR contacts the old VoIPLR in order to cancel the stored profile at the old VoIPLR. The identity (including address) of the old VoIPLR can be either derived from the previously stored SNA_ID of the sub-network area where the terminal was previously connected or from the SNA_ID provided from the subscriber terminal. The Home VoIPLR then contacts the old VoIPLR and cancels this outdated Roaming subscriber profile stored there (because the subscriber is no longer located or connected there).

However, at block 325, if the serving VoIPLR is not the subscriber's Home VoIPLR, blocks 340 and 345 are performed.

At block 340, the serving VoIPLR contacts the Home VoIPLR (based on the VoIPLR_ID) and provides the subscriber terminal's current location (e.g., IP address where calls directed to the subscriber can be routed and the serving SNA_ID) and status (e.g., connected or not connected) to the Home VoIPLR. The Home VoIPLR will also cancel the old Roaming profile located at the VoIPLR to which the subscriber was previously connected (only if this old VoIPLR is not the Home VoIPLR).

At block 345, the serving VoIPLR stores a Roaming profile for the subscriber received from the subscriber's Home VoIPLR, including the subscriber's SubscriberID, the subscriber's updated location and status . The stored IP address is a temporary IP address that corresponds, for example, to the new area or subnetwork where the subscriber is located or connected.

This registration procedure can be performed when the subscriber roams and connects to a new MVoIP, a new subnetwork, or to a new subnetwork area, etc. In this manner, updated location information (including an updated IP address corresponding to the

geographic location, area, subnetwork where the subscriber is located) and status information for the subscriber are always maintained in one central known location (the subscriber's Home VoIPLR). By maintaining this status and location information in one known location for the subscriber terminal, this information can be retrieved by entities (e.g., gateways and gatekeepers) and used to deliver IP telephony calls to the subscriber terminal regardless where the terminal is located.

Call Delivery from PSTN TO MVoIP Network Subscribers

Fig. 4 is a flow chart illustrating call delivery to a subscriber from a PSTN according to an embodiment of the present invention. Fig. 5 is a diagram illustrating call delivery to a subscriber from a PSTN according to an embodiment of the present invention. Referring to Figs. 4 and 5, when the subscriber's directory number (DN) is dialed outside the MVoIP network, block 405, a PSTN call is directed towards one of the Mobile IP Telephony gateways (MITGWs) of the home MVoIP network of the called subscriber, block 410. This is illustrated as step 1 in Fig. 5.

At block 415, the MITGW identifies the VoIPLR_ID (which identifies the Home VoIPLR of the subscriber) corresponding to the dialed DN. The MITGW can identify the VoIPLR_ID corresponding to the DN using a look-up table or other technique.

At block 420, The MITGW contacts the subscriber's Home VoIPLR (corresponding to the dialed DN) and provides the DN to the Home VoIPLR in order to have the dialed number (DN) translated into an IP address to set-up an IP telephony call towards the location of the subscriber. This is illustrated as step 2 in Fig. 5.

At block 425, in order to translate the dialed DN (or other specified alias) to the destination IP address (of the called subscriber), the Home VoIPLR retrieves the current location and status stored of the called subscriber (e.g., from the subscriber's complete profile in the Home VoIPLR) and provides the MITGW with the destination IP address towards which the call should be forwarded to reach the called subscriber. This corresponds to step 3 in Fig. 5.

The MITGW sets up an IP telephony call from itself towards the destination IP address received from the VoIPLR (indicating the subscriber's current location), and indicating that

the call is directed towards the DN (i.e., DN is used as an alias), block 430. This is illustrated as step 4 in Fig. 5.

An example of this type of call can be described with reference to Fig. 2. A terminal X 252 (e.g., which is not a MVoIP network subscriber) dials the DN corresponding to subscriber terminal Y 222. In this example it is assumed that VoIPLR 1 220 is the Home VoIPLR for terminal Y 222. The PSTN call is routed to MITGW 1 260, for example. MITGW 1 contacts VoIPLR 1 220 to obtain the current IP address of terminal Y 222. After obtaining the IP address of terminal Y, MITGW 1 260 sets up an IP telephony between itself and the IP address of terminal Y 222 or gatekeeper 208 (i.e., data packets can be routed through gatekeeper 208 or directly to terminal Y). For example, the IP telephony call may be established using the IP address of MITGW 1 260 as the source address) and the IP address of terminal Y 222 or the IP address of gatekeeper 208 as a destination address).

Delivery To MVoIP Network Subscribers For Calls Originated Within The MVoIP Networks

When the subscriber's directory number (DN) or other Alias is dialed, two situations are possible: 1) the calling party is registered in the MVoIP network with a control entity (e.g. the gatekeeper in the H.323 standard) that controls the provisioning of services and the routing of calls; or 2) there is no control entity. These two situations will be briefly discussed.

Fig. 6 is a flow chart illustrating call delivery within the MVoIP network where the calling party is registered with a control entity. In block 605, the calling subscriber registers with a control entity (e.g., gatekeeper). At block 610, the calling subscriber contacts the control entity and requests an IP telephony call to a called subscriber corresponding to a DN. The DN is provided to the control entity.

At block 615, the control entity identifies the VoIPLR_ID corresponding to the DN (identifying the Home VoIPLR of the called subscriber) .

At block 620, the control entity contacts the called subscriber's Home VoIPLR. At block 625, the control entity obtains the destination IP address of the called subscriber (corresponding to DN) from the Home VoIPLR.

At block 630, the control entity sets up an IP telephony call over the IP network from the calling subscriber terminal to the destination IP address of the called subscriber.

If the called subscriber's Home VoIPLR cannot be reached (either because the called party is not a MVoIP network subscriber or due to technical/roaming agreement problems), the call is routed as a call towards the PSTN (e.g., routed to the nearest MITGW for routing to the PSTN) using the dialed DN as destination. On the called side, this received call is managed as an incoming call from PSTN, described in Fig. 4.

If no control entity is available, the call is routed as a call towards PSTN using the dialed DN as destination. On the called side, this case is managed as an incoming call from PSTN, described in Fig. 4.

Several embodiments of the present invention are specifically illustrated and/or described herein. However, it will be appreciated that modifications and variations of the present invention are covered by the above teachings and within the purview of the appended claims without departing from the spirit and intended scope of the invention.

WHAT IS CLAIMED IS:

1. A method of allowing subscribers to roam between sections of a packet-switched telephony network comprising the steps of:
a subscriber terminal connecting to a first section of a packet-switched telephony network, the first section of the network being different from a subscriber terminal's home section of the network;
updating location information stored in a home location register, the location information indicating the current location of the subscriber terminal, the home location register corresponding to the subscriber terminal's home section of the network;
receiving a request to establish a call to the subscriber terminal;
obtaining the location information identifying the location of the subscriber terminal from the home location register; and
setting up a packet-switched telephony call to the location of the subscriber terminal.

2. The method of claim 1 and further comprising the step of the subscriber terminal registering the location information in a serving location register corresponding to the first section of the network, the location information indicating the location of the subscriber terminal, said step of updating being performed based on the location information stored in the serving location register.

3. The method of claim 2 wherein said step of registering the location information indicating the location of the subscriber terminal comprises the step of the subscriber terminal registering with the serving location register a temporary network address at which the subscriber terminal can be reached while the subscriber terminal is connected to the first section of the network.

4. The method of claim 1 wherein said step of a subscriber terminal connecting comprises the step of a subscriber terminal connecting to a first network, the first network being

different from a subscriber terminal's home network, the first network and the home network each being part of a main network wherein the subscriber terminal may roam.

5. The method of claim 1 wherein said step of a subscriber terminal connecting comprises the step of a subscriber terminal connecting to a first subnetwork, the first subnetwork being different from a subscriber terminal's home subnetwork, the first subnetwork and the home subnetwork each being part of the network wherein the subscriber terminal may roam.

6. The method of claim 1 wherein said step of receiving a request to establish a call to the subscriber terminal comprises the step of a caller placing a call to the subscriber terminal by dialing an alias corresponding to the subscriber terminal, the step of obtaining the location information comprises the steps of:
identifying an address corresponding to the subscriber terminal's home location register based on the subscriber terminal's alias;
contacting the subscriber terminal's home location register; and
obtaining the location information identifying the subscriber terminal's location from the home location register.

7. The method of claim 6 wherein said alias comprises a directory number corresponding to the subscriber terminal.

8. The method of claim 6 wherein said alias comprises a logical name corresponding to the subscriber terminal.

9. The method of claim 6 wherein said step of a caller placing a call comprises the step of a caller located outside the packet-switched telephony network placing a call to the subscriber terminal by dialing an alias corresponding to the subscriber terminal.

10. The method of claim 6 wherein said step of a caller placing a call comprises the step of a caller located inside the packet-switched telephony network placing a call to the subscriber terminal by dialing an alias corresponding to the subscriber terminal.

11. The method of claim 1 wherein said step of setting up comprises the step of setting up an Internet Protocol (IP) telephony call to the location of the subscriber terminal.

12. A method of allowing subscribers to roam between sections of a packet-switched telephony network comprising the steps of:
providing a subscriber terminal's SubscriberID to a serving location register where the subscriber terminal is located;
the serving location register storing updated location information and the SubscriberID for the subscriber terminal, the location information indicating the location of the subscriber terminal;
the serving location register contacting a home location register of the subscriber terminal and providing the subscriber terminal's SubscriberID and the location information to the subscriber terminal's home location register;
receiving a request for a call to the subscriber terminal;
establishing a packet-switched telephony call to the subscriber terminal based on the subscriber terminal's updated location information stored in the subscriber terminal's home location register.

13. The method of claim 12 wherein the step of providing a subscriber terminal's SubscriberID comprises the steps of:
obtaining updated location information for the subscriber terminal;
the subscriber terminal contacting a control entity where the subscriber terminal is located;
providing a SubscriberID of the subscriber terminal and the subscriber terminal's updated location information to the control entity; and

providing the subscriber terminal's SubscriberID and updated location information from the control entity to a serving location register where the subscriber terminal is located.

14. The method of claim 13 wherein said step of the subscriber terminal contacting a control entity where the subscriber terminal is located comprises the step of the subscriber terminal contacting a gatekeeper where the subscriber terminal is located.

15. A method of allowing subscribers to roam between sections of a packet-switched telephony network comprising the steps of:
obtaining updated location information indicating a current location of a subscriber terminal;
providing a subscriber terminal's SubscriberID and the updated location information to a serving location register where the subscriber terminal is located;
the serving location register storing the subscriber terminal's updated location information and the SubscriberID;
the serving location register contacting a home location register of the subscriber terminal and providing the subscriber terminal's SubscriberID and the updated location information to the subscriber terminal's home location register;
receiving a request for a call to the subscriber terminal; and
establishing a packet-switched telephony call to the subscriber terminal based on the subscriber terminal's updated location information stored in the subscriber terminal's home location register.

16. A method of allowing subscribers to roam between sections of a packet-switched telephony network comprising the steps of:
a subscriber terminal obtaining an updated address at which the subscriber terminal can be reached while located in a first section of the IP-telephony network, the first section of the network being different from the subscriber terminal's home section of the network;

the subscriber terminal providing its subscriberID and updated address to a serving location register corresponding to the first section of the network where the subscriber terminal is located;

the serving location register storing a roaming profile for the subscriber terminal including the subscriber terminal's subscriberID and the subscriber terminal's updated address;

identifying a home location register for the subscriber terminal based on the subscriberID, the subscriber terminal's home location register corresponding to the home section of the network;

providing the subscriber terminal's subscriberID and updated address from the serving location register to the subscriber's home location register; and

storing the updated address for the subscriber terminal at the home location register.

17. The method of claim 16 and further comprising the steps of:

receiving a directory number corresponding to the subscriber and a request to establish a call to the subscriber terminal;

identifying the subscriber terminal's home location register based on the directory number;

obtaining the subscriber terminal's updated address from the subscriber's home location register; and

establishing a packet-switched telephony call to the subscriber terminal using the subscriber terminal's updated address.

18. The method of claim 16 wherein each of said sections of the packet-switched telephony network comprise a section of an Internet Protocol (IP) telephony network.

19. The method of claim 16 and further comprising the steps of:

identifying a serving location register corresponding to a section of the network where the subscriber terminal was previously located; and

canceling a roaming profile for the subscriber stored in the serving location register corresponding to the section of the network where the subscriber terminal was previously located.

20. A packet-switched telephony network that allows subscribers to roam, comprising:
a first section of a packet-switched telephony network;
a first location register corresponding to the first section of the network, the first location register storing a network address for a subscriber terminal, the network address being valid when the subscriber is connected to the first section of the network;
a home section of the network coupled to the first section;
a home location register corresponding to the home section, the home location register receiving and storing the subscriber terminal's current network address from the first location register, the home location register also storing an alias corresponding to the subscriber terminal;
a gateway coupled to the home section of the network, the gateway obtaining the current network address corresponding to the alias from the home location register and then establishing a packet-switched telephony call towards the current network address in response to receiving a call request and the alias corresponding to the called subscriber.

21. The packet-switched telephony network of claim 20 and further comprising a control entity that is connected to one of the subnetworks.

22. The packet-switched telephony network of claim 20 wherein said packet-switched telephony network comprises an Internet Protocol (IP)-telephony network.

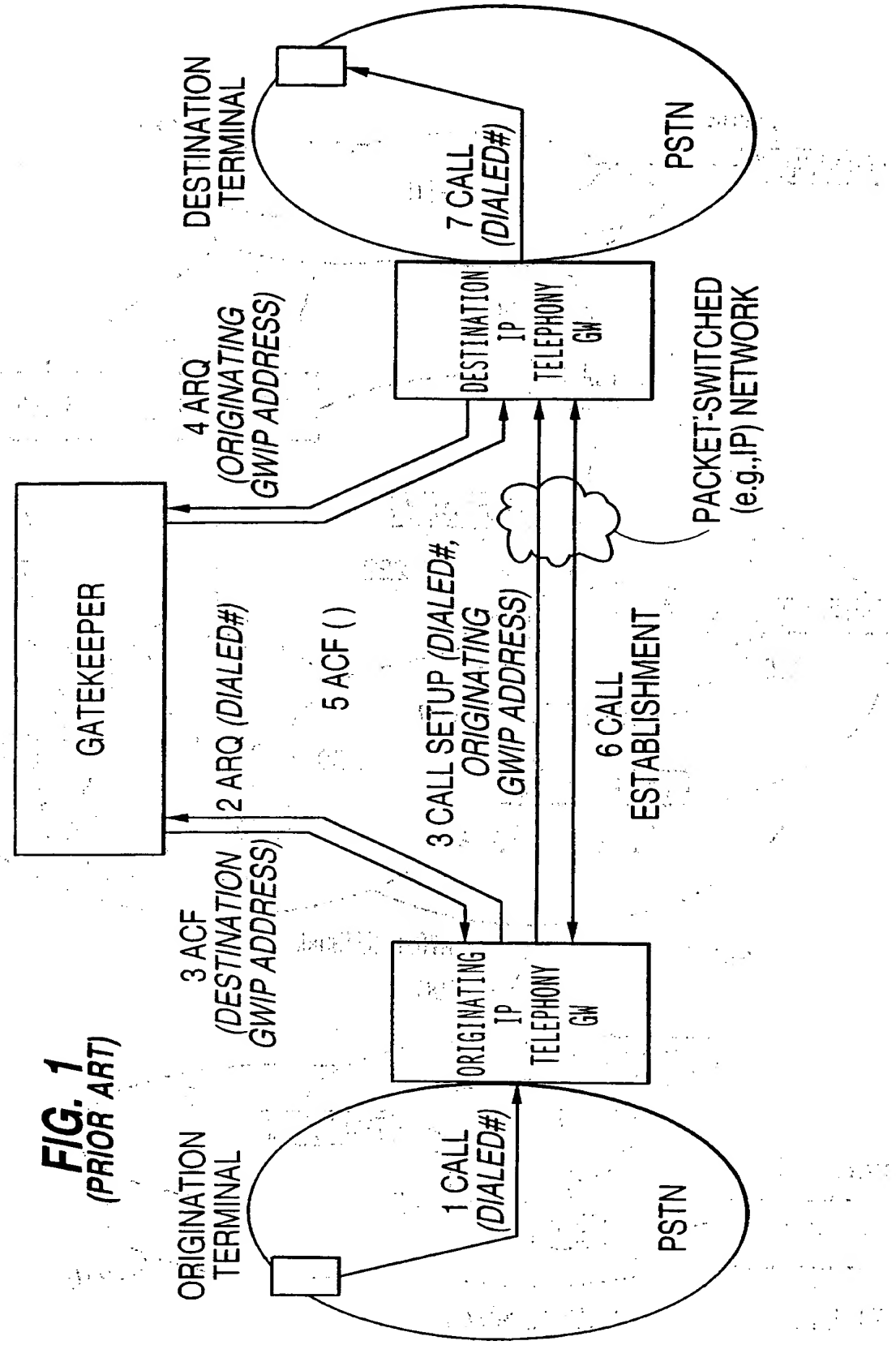


FIG. 1
(PRIOR ART)

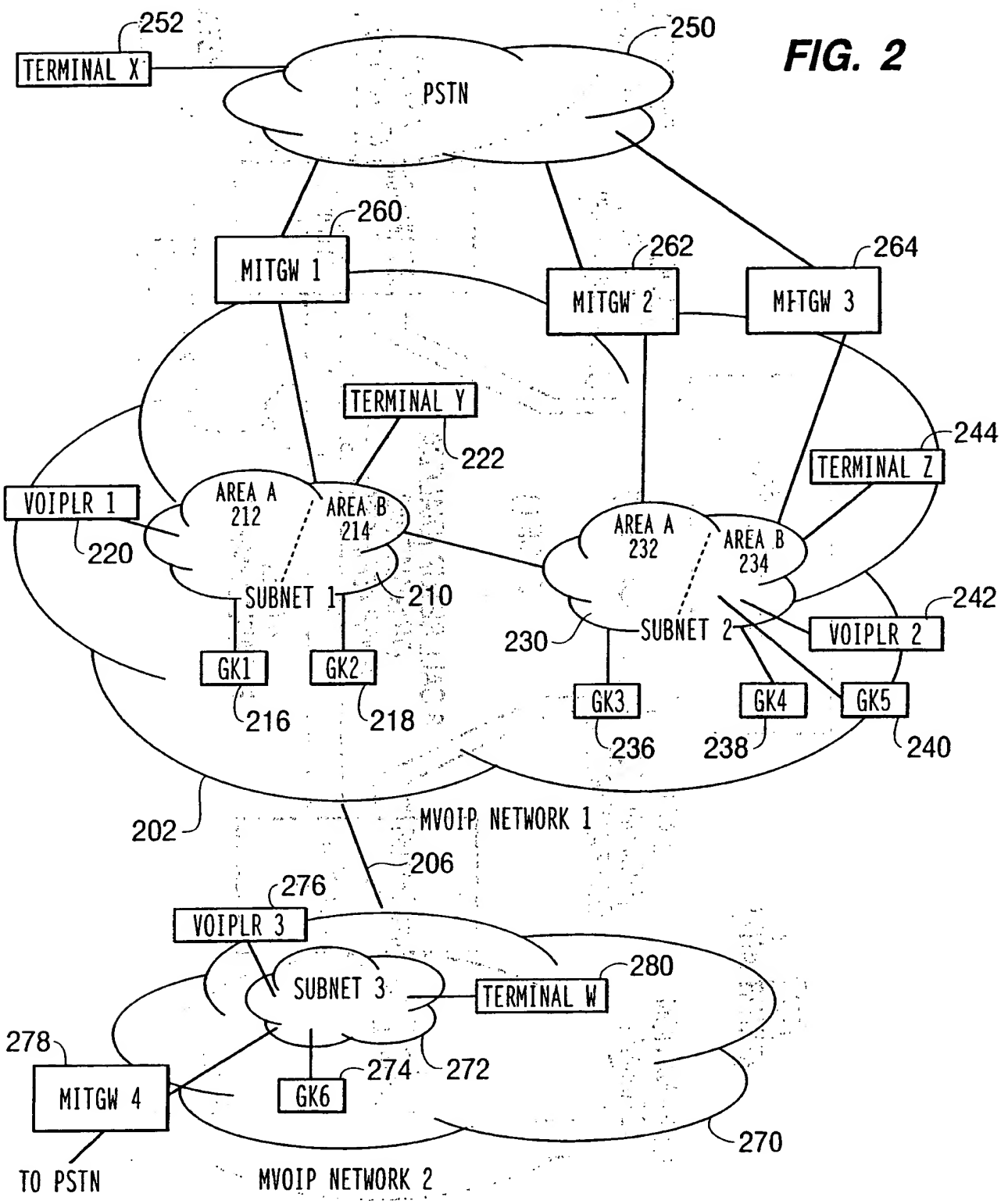

252
TERMINAL X
250
PSTN
260
MITGW 1
262
MITGW 2
264
MITGW 3
TERMINAL Y
222
244
TERMINAL Z
VOIPLR 1
220
AREA A
212
AREA B
214
AREA A
232
AREA B
234
SUBNET 1
210
230
SUBNET 2
242
VOIPLR 2
GK1
GK2
GK3
GK4
GK5
216
218
236
238
240
202
MVOIP NETWORK 1
206
276
VOIPLR 3
SUBNET 3
280
TERMINAL W
278
MITGW 4
274
GK6
272
270
TO PSTN
MVOIP NETWORK 2

FIG. 2

FIG. 3

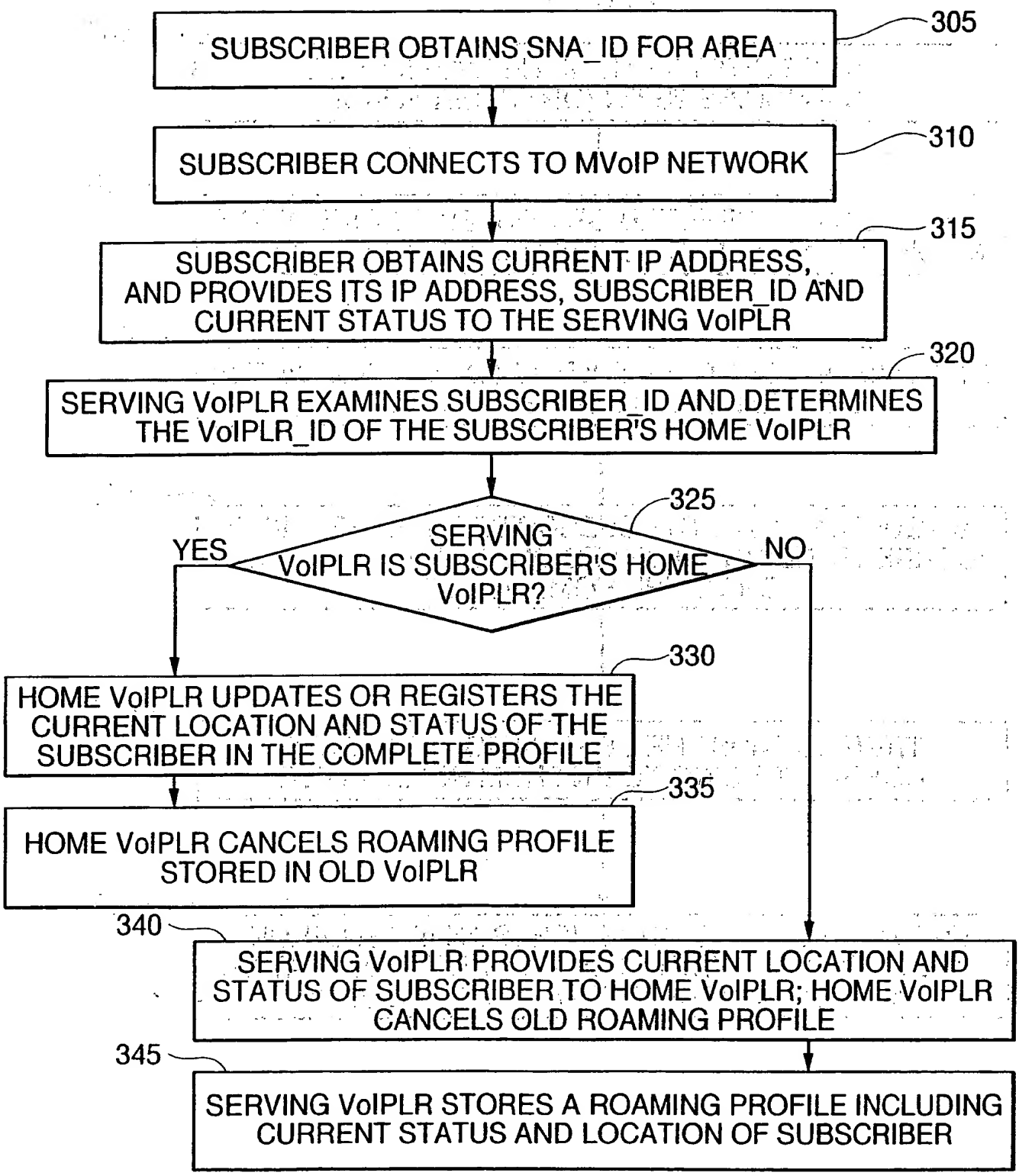

SUBSCRIBER OBTAINS SNA_ID FOR AREA
305
SUBSCRIBER CONNECTS TO MVoIP NETWORK
310
SUBSCRIBER OBTAINS CURRENT IP ADDRESS, AND PROVIDES ITS IP ADDRESS, SUBSCRIBER_ID AND CURRENT STATUS TO THE SERVING VoIPLR
315
SERVING VoIPLR EXAMINES SUBSCRIBER_ID AND DETERMINES THE VoIPLR_ID OF THE SUBSCRIBER'S HOME VoIPLR
320
SERVING VoIPLR IS SUBSCRIBER'S HOME VoIPLR?
325
YES
NO
HOME VoIPLR UPDATES OR REGISTERS THE CURRENT LOCATION AND STATUS OF THE SUBSCRIBER IN THE COMPLETE PROFILE
330
HOME VoIPLR CANCELS ROAMING PROFILE STORED IN OLD VoIPLR
335
SERVING VoIPLR PROVIDES CURRENT LOCATION AND STATUS OF SUBSCRIBER TO HOME VoIPLR; HOME VoIPLR CANCELS OLD ROAMING PROFILE
340
SERVING VoIPLR STORES A ROAMING PROFILE INCLUDING CURRENT STATUS AND LOCATION OF SUBSCRIBER
345

FIG. 4

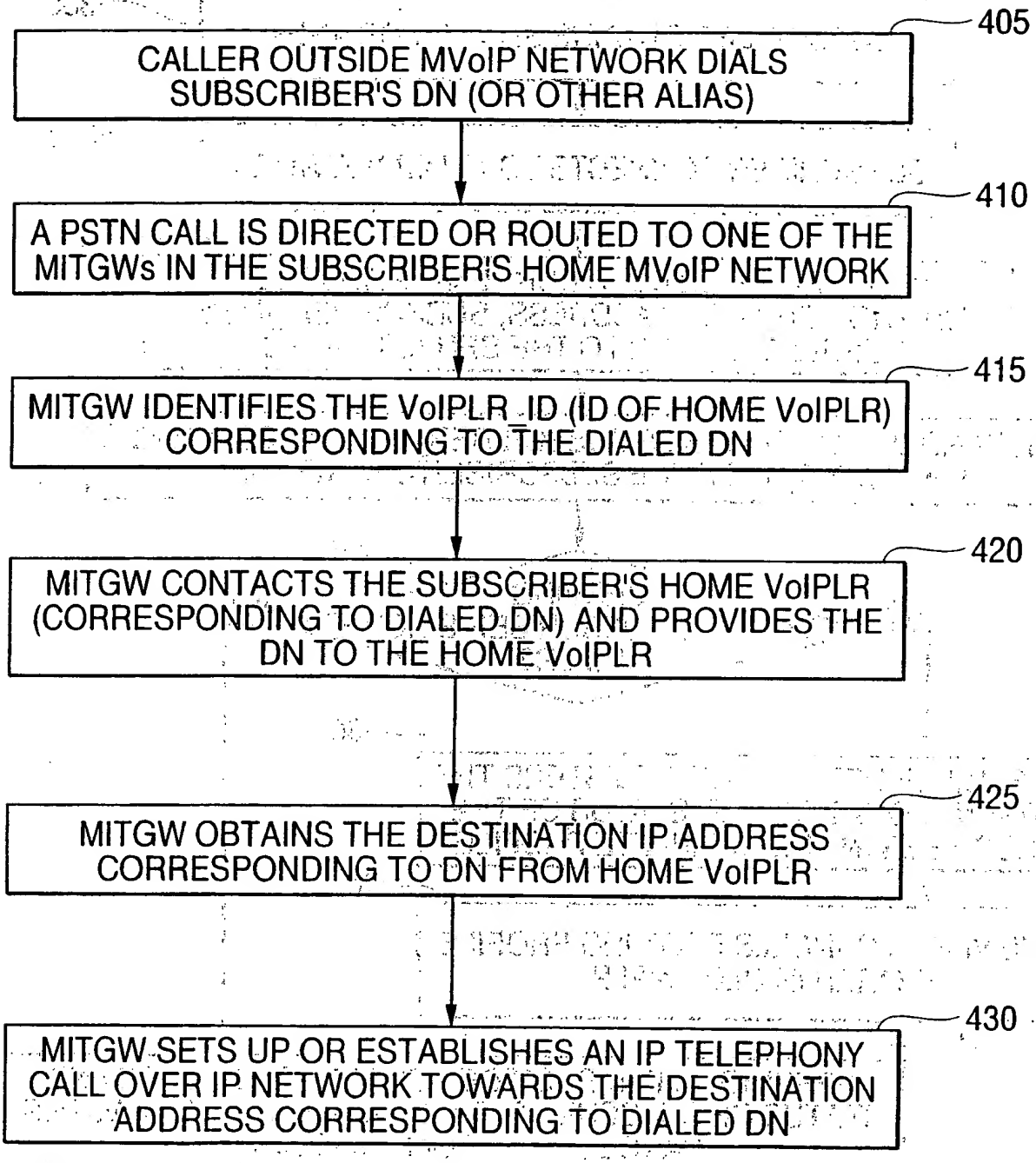

405
CALLER OUTSIDE MVoIP NETWORK DIALS SUBSCRIBER'S DN (OR OTHER ALIAS)
410
A PSTN CALL IS DIRECTED OR ROUTED TO ONE OF THE MITGWs IN THE SUBSCRIBER'S HOME MVoIP NETWORK
415
MITGW IDENTIFIES THE VoIPLR_ID (ID OF HOME VoIPLR) CORRESPONDING TO THE DIALED DN
420
MITGW CONTACTS THE SUBSCRIBER'S HOME VoIPLR (CORRESPONDING TO DIALED DN) AND PROVIDES THE DN TO THE HOME VoIPLR
425
MITGW OBTAINS THE DESTINATION IP ADDRESS CORRESPONDING TO DN FROM HOME VoIPLR
430
MITGW SETS UP OR ESTABLISHES AN IP TELEPHONY CALL OVER IP NETWORK TOWARDS THE DESTINATION ADDRESS CORRESPONDING TO DIALED DN

FIG. 5

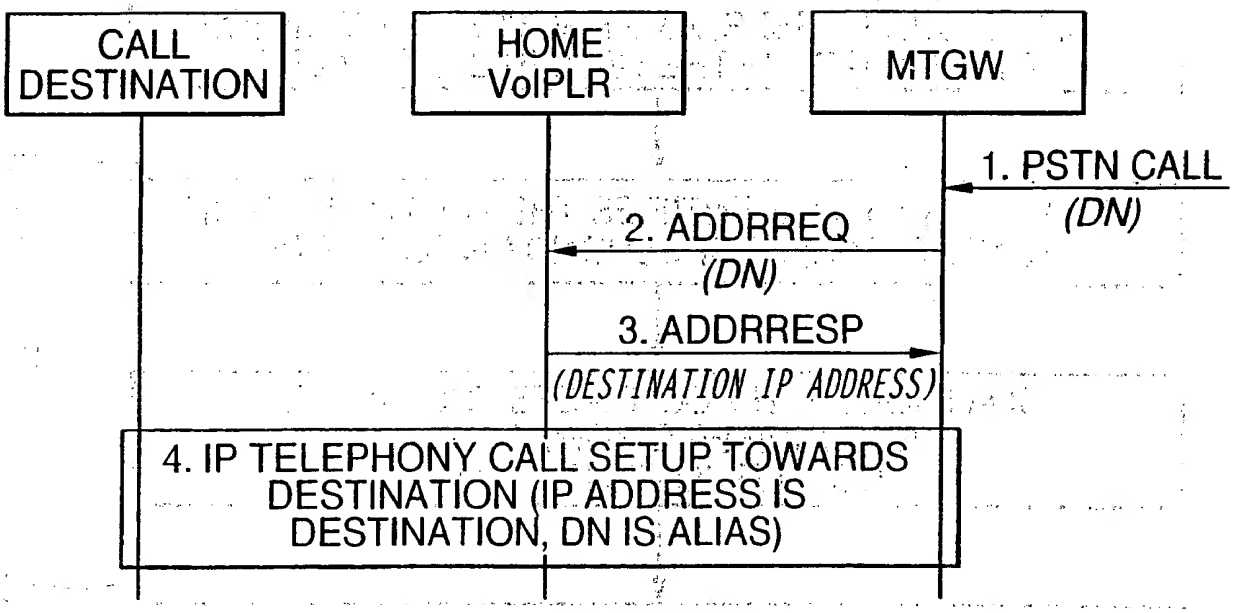
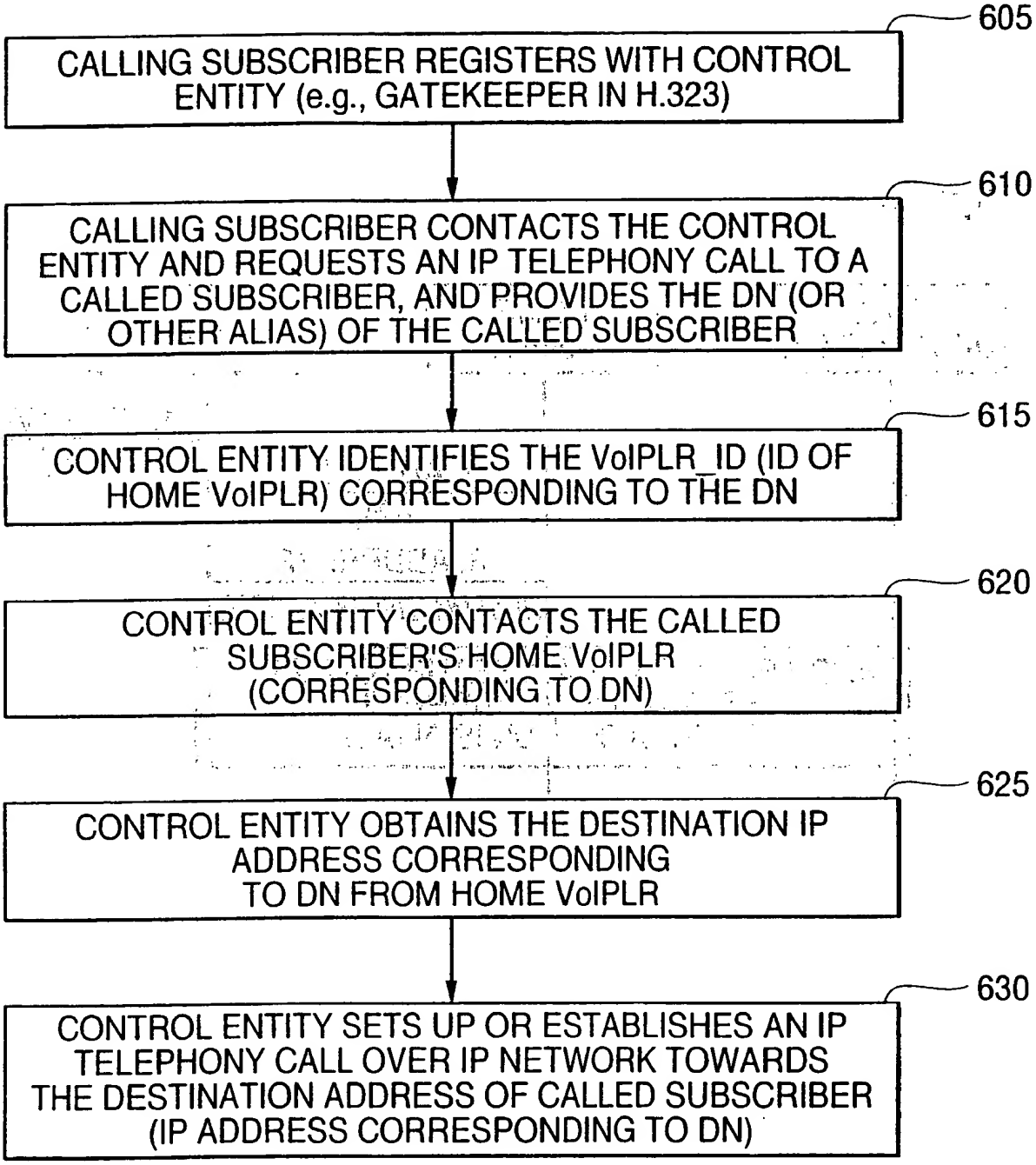

CALL DESTINATION
HOME VoIPLR
MTGW
1. PSTN CALL
(DN)
2. ADDRREQ
(DN)
3. ADDRRESP
(DESTINATION IP ADDRESS)
4. IP TELEPHONY CALL SETUP TOWARDS DESTINATION (IP ADDRESS IS DESTINATION, DN IS ALIAS)

FIG. 6


605
CALLING SUBSCRIBER REGISTERS WITH CONTROL ENTITY (e.g., GATEKEEPER IN H.323)
610
CALLING SUBSCRIBER CONTACTS THE CONTROL ENTITY AND REQUESTS AN IP TELEPHONY CALL TO A CALLED SUBSCRIBER, AND PROVIDES THE DN (OR OTHER ALIAS) OF THE CALLED SUBSCRIBER
615
CONTROL ENTITY IDENTIFIES THE VoIPLR_ID (ID OF HOME VoIPLR) CORRESPONDING TO THE DN
620
CONTROL ENTITY CONTACTS THE CALLED SUBSCRIBER'S HOME VoIPLR (CORRESPONDING TO DN)
625
CONTROL ENTITY OBTAINS THE DESTINATION IP ADDRESS CORRESPONDING TO DN FROM HOME VoIPLR
630
CONTROL ENTITY SETS UP OR ESTABLISHES AN IP TELEPHONY CALL OVER IP NETWORK TOWARDS THE DESTINATION ADDRESS OF CALLED SUBSCRIBER (IP ADDRESS CORRESPONDING TO DN)

INTERNATIONAL SEARCH REPORT

Intern ıal Application No
PCT/US 00/14021

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04Q7/22 H04L29/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04Q H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LIAO W: "MOBILE INTERNET TELEPHONY: MOBILE EXTENSIONS TO H.323" PROCEEDINGS IEEE INFOCOM. THE CONFERENCE ON COMPUTER COMMUNICATIONS,US,NEW YORK, NY: IEEE, 21 March 1999 (1999-03-21), pages 12-19, XP000868780 ISBN: 0-7803-5418-4 page 13, right-hand column, line 24-36 page 14, left-hand column, line 1 -page 15, left-hand column, line 16	1-22
X	WO 98 39934 A (NORTHERN TELECOM LTD) 11 September 1998 (1998-09-11) page 20, line 3 -page 25, line 21	1-13, 15-18, 20-22

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 September 2000	12/09/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Weinmiller, J

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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern ial Application No
PCT/US 00/14021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9839934 A	11-09-1998	AU 5977198 A	22-09-1998
		EP 0965233 A	22-12-1999